## **ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)**

February 2000

BUDGET ACTIVITY

## 2 - Applied Research

PE NUMBER AND TITLE

0602601A Combat Vehicle and Automotive Technology

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COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	38139	54776	63589	64724	47677	53068	56933	Continuing	Continuing
DC05 Armor Exploratory Development	6375	8399	13456	13417	14103	15304	15891	Continuing	Continuing
DC84 AC84	854	0	0	978	976	1948	2916	Continuing	Continuing
AH58 Joint Robotic Development Program on Ground Vehicle Survivability	2890	0	0	0	0	0	0	0	2890
AH77 Advanced Automotive Technology	17830	29782	16596	16497	16610	17280	17269	Continuing	Continuing
AH82 Non-Ozone Depleting Substance Technology	1304	0	0	0	0	0	0	0	1304
AH91 Tank and Automotive Technology	8886	16595	12865	14268	15988	18536	20857	Continuing	Continuing
AHH7 Future Combat Systems (FCS)	0	0	7752	19564	0	0	0	27500	27316
AT21 21st Century Truck (T21)	0	0	12920	0	0	0	0	0	12920

A. Mission Description and Budget Item Justification: The Army's new vision calls for a more strategically responsive force that dominates across the full spectrum of operations. To achieve this new vision, the Army must transform itself to a force that is more strategically deployable and agile, with a smaller logistical footprint, where light forces become more lethal, survivable and tactically mobile. The work performed provides technologies that are needed to achieve this vision. The Army's top priority Science and Technology program, Future Combat Systems (FCS), is identified within this PE under a new project AHH7. This project contains funds to support concept exploration and trade studies leading to demonstrations of FCS. Activities within this program element are focused primarily on FCS; but spin-off opportunities for upgrades will be identified. Other major projects within this PE include: AH91, which provides critical enabling technologies that support FCS and other thrusts aimed at solving warfighter needs; DC05, which addresses armor technology; and AH77, which funds the National Automotive Center (NAC). The NAC leverages commercial industry's large investment in automotive technology research and development, and pursues shared technology programs that focus benefiting military ground vehicles. This PE supports efforts to identify and evaluate non-ozone depleting, fire suppressant alternatives to Halon 1301 for combat vehicles. This PE is managed by the Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI. It adheres to Tri-Service Reliance Agreements on advanced materials; fuels and lubricants; and ground vehicles; with oversight and coordination provided by the Joint Directors of Laboratories. There is no duplication of effort within the

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Exhibit R-2 (PE 0602601A)

# **ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)**

DATE

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BUDGET ACTIVITY

### 2 - Applied Research

PE NUMBER AND TITLE

0602601A Combat Vehicle and Automotive Technology

Army, or DoD. The project is coordinated with the Marine Corps office through the Naval Surface Warfare Center; and with other ground vehicle developers within the Departments of Energy, Commerce and Transportation and the Defense Advanced Research Projects Agency (DARPA).

B. Program Change Summary	FY 1999	FY 2000	FY 2001
Previous President's Budget ( <u>FY 2000</u> PB)	39208	39749	41625
Appropriated Value	39562	55249	
Adjustments to Appropriated Value			
a. Congressional General Reductions	-354		
b. SBIR / STTR	-694		
c. Omnibus or Other Above Threshold Reductions	-156	-159	
d. Below Threshold Reprogramming	-219		
e. Rescissions		-314	
Adjustments to Budget Years Since FY 2000 PB			+18899
New Army Vision/Transformation Adjustment	-	TBD	+3065
Current Budget Submit (FY 2001 PB)	38139	54776	63589

Change Summary Explanation: Funding - FY 2001 – Increase reflects restructure of funding for FCS (+7800), increase for 21<sup>st</sup> Century Truck (+12920) and other minor adjustments (this includes six minor programs totaling +1244). Funding – FY01: Project C05 was adjusted to reflect the new Army Vision/Transformation.

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Exhibit R-2 (PE 0602601A)

		ARMY RDT&E BUDGET ITE	EM JUS	TIFICAT	ION (R-	2A Exhi	bit)		DATE <b>Fe</b>	bruary 20	000
BUDGET ACTIVITY  2 - Applied Research					UMBER AND 102601A (Chnology	Combat \	/ehicle a	nd Autor	PROJECT DC05		
		COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
DC05 Arm	or Explorato	ory Development	6375	8399	13456	13417	14103	15304	15891	Continuing	Continuing
space, performance, projectiles, Laboratory Starting in concept res Energy, an against diff	explosived programs FY01, fur eearch, this d industriate ferent three west Research	ative, non-armor survivability techniques, and cost ranges appropriate to U.S. ground ly formed penetrators, chemical energy wa, e.g., PE 0602618A (Ballistic Technology ading in the project has been augmented to a project includes supporting work in armo al and academic sources. Supporting work ats, with sufficiently high fidelity to make arch Institute, San Antonio, TX; University hements:	combat system and be project AH8 research sign materials, be also include their implem	ems, and problems, and fra blast and fra 60) and PE 0 nificantly light bringing tog as researching mentation in	otection of congress of congre	ombat and tan a land mines aterials proje solutions that lective expe- ing of armonable and afformation	actical vehicle. This project AH84), as at eventually rtise of the Imperformance or dable. Major and the Imperformance or dable.	les against s ect draws upon s well as innot can transiti Department of the models to jor contractor	uch threats a on products ovative armo on to FCS in of Defense, t assess armo	s Kinetic Er from Army I ors from indo I. In addition the Department or configuration	Research ustry. In to armor ent of
•		<ul> <li>Investigated smart armor package defeativehicles against medium caliber automat</li> </ul>				vings, provid	ling the tech	nological ba	sis for prote	ction of ligh	ter
•	1307	<ul> <li>Created an armor virtual prototyping sy of future vehicles and armor upgrades to</li> <li>Validated methods for ceramic armor defection</li> <li>Completed research showing 25% reduced</li> </ul>	existing vehiclesign using a	will use mod icles. analytical m	deling and si	end the capa	bilities of the	e virtual pro	ototyping sys	tem.	nent cost
•	1050	- Completed assessment of electrodynamic									
•	950	- Investigated combined armor/signature		_							
•	1600	<ul> <li>Completed fabrication of base structure under movement in otherwise non-protec</li> <li>Completed and tested survivability appl</li> </ul>	ted tactical v	ehicles.	• •	strator, prov	iding enhand	ced small ar	ms and mine	protection t	to troops
Total	6375	2 2	-1505 101 140								

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	4	ARMY RDT&E BUDGET ITEM JUST	TIFICATION (R-2A Exhi	bit) Pebru	ary 2000
BUDGET AG	CTIVITY Ilied Res	search	PE NUMBER AND TITLE 0602601A Combat V Technology	ehicle and Automotive	PROJECT DC05
FY 2000 P	Planned Pi	ogram:			
•	1360	- Investigate armors for medium caliber KE threats that and deployable combat vehicles.	at are 50% more space efficient than	the 1996 state of the art, making possib	le more compact
•	1458	- Research and define lightweight armor systems again	nst a spectrum of threats faced by vel	nicles in the 18-40 ton weight range.	
•		- Characterize the debris produced by KE and Chemica			ction Systems
		(APS), to provide the foundation for the lightweight ar			
•	971	- Define, through simulation and component test, the s			ructure systems
	4.450	that will dramatically reduce the weight of combat syst			
•	1458	- Integrate armor configurations from 0602618A/AH80	0 and material and structure technological	ogy from 0602105A/AH84 into multipl	e armor/structur
_	1/25	systems for demonstration in FY 2001 Complete fabrication of troop protection prototype de	nmonstrator		
•	361	- In partnership with United Kingdom (UK), develop		nique electro-dynamic defeat, of anti-arn	nor threats
•	301	technology constructs, for combat vehicle upgrades and		inque electro dynamic delett, or anti-am	nor tireats
•	191	- Small Business Innovative Research/Small Business			
Total	8399				
EX7 2001 E	N J D-				
• Y 2001 P	Planned Pi 3027	<ul><li>ogram:</li><li>Part of these funds will be used in support of the New</li></ul>	y Army Vision/Transformation Pro	ve the feesibility of armor systems with	20% granter
•	3021	weight efficiency than the 1996 state of the art against			
		will provide vehicles in the 18-40 ton range with the su			urmor systems
•	2490	- Part of these funds will be used in support of the New	• •		s to complement
		future APS with 30% greater weight efficiency than the			1
•	2192	- Complete investigation of a series of integrated multi			
		improved weight efficiency over the Composite Armor		oduction cost less that 1.5 times that of t	the CAV,
	2200	providing improved survivability at an affordable cost.		WE ISEN OF THE P	X.0.0
•	2399				
•	1593	- Funds will be used in support of the New Army Visio to provide industry the capability to design and validate	•		is and design too
	697	- Funds will be used in support of the New Army Visio			national
	0,1	cooperative research program for mine blast characteri			

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		ARMY RDT&E BUDGET ITEM JUSTIFIC	CATION (R-2A Exhibit)	DATE February 2000
BUDGET ACT  2 - Applie		search	PE NUMBER AND TITLE 0602601A Combat Vehicle and Auto Technology	project DC05
•	697	- Funds will be used in support of the New Army Vision/Tramodule	nnsformation. Conduct safety and user assessments	of the protected troop transport
FY 2001 PI	l <b>anned I</b> 361	Program: (continued) - In partnership with UK, develop a set of design tools to in	vestigate unique electro dynamic defeat of anti-armo	or threats, technology constructs for
	301	combat vehicle upgrades and concepts.	vestigate unique electro dynamic deleta of unit urino	in the distriction of the constructs for
Total	13456			
Project DC0	)5	Paga	e 5 of 17 Pages Exhi	bit R-2A (PE 0602601A)

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ARMY RDT&E BUDGET IT	February 2000									
PE NUMBER AND TITLE  2 - Applied Research  0602601A Combat Vehicle and Automote Technology							notive		PROJECT <b>AH58</b>	
COST (In Thousands)	FY1999 Actual	FY 200 Estimat	-	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH58 Joint Robotic Development Program on Ground Vehicle Survivability	2890		0	0	0	0	0	0	0	2890

Mission Description and Justification: This one year Congressionally directed project researches and matures components for robotic and semi-robotic military vehicles, which were not specific to any single system. This project integrated vehicle survivability, mobility, intra-vehicular digital electronics, and other diverse vehicle technologies developed by the Army, other DoD laboratories and industry. It focused on two critical areas of deficient performance in robotic and semi-robotic vehicles: mobility and navigation. High priority components were (1) "smart" running gear (e.g., integral in-hub electric drive, tire inflation control, active shock absorption, etc., and sensors for motor torque, wheel velocity, etc.), and (2) semi-autonomous navigation (e.g., machine perception hardware and software for terrain characterization, obstacle detection and crossing or avoidance, path selection, and remote operator interface). Using robotics rather than a manned crew in a vehicle greatly removes the need for armor and reduces vehicle size to present a smaller target. Robotics has payoffs for manned systems as well crew workload. Work on this project was consistent with the Joint Service Unmanned Ground Vehicle Master Plan. The project also developed a Systems Integration Laboratory (SIL) to assess the compatibility of robotic/semi-autonomous vehicle locomotion and navigation sub-systems, to assess net vehicle performance, to design interfaces, and to optimize/harmonize the performance and characteristics of the subsystems. FY98 Intelligent Mobility Robotics contracts were awarded to Utah State University, Logan, UT; General Dynamics Land Systems, Muskegon, MI; Turing Associates, Ann Arbor, MI; and Tennessee State University, Nashville, TN. This project was completed in FY99.

#### FY 1999 Accomplishments:

- 2592
  - Completed upgrade to contractor's 100lb. robotic vehicle to include z-axis omni-directional steering capability for complete 6-degree of freedom electric wheel control.
    - Completed improvement of contractor's existing 1000 lb. robotic vehicle intelligent path planning and control algorithms conditions.
    - Completed research showing the scalability of both (100 lb. and 1000 lb.) weight class unmanned ground vehicles (UGVs) to man-portable robot applications and follow-on programs.
    - Completed construction of the robotic vehicle SIL for technology test and evaluation.
- 298 Participated in Simulation Based Acquisition demonstration for the Total Life Cycle (SIM-TLC).

Total 2890

FY 2000 Planned Program: Project not funded in FY 2000.

FY 2001 Planned Program: Project not funded in FY 2001.

Project AH58 Page 6 of 17 Pages Exhibit R-2A (PE 0602601A)

ARMY RDT&E BUDGET IT	DATE February 2000								
BUDGET ACTIVITY  2 - Applied Research		PE NUMBER AND TITLE 0602601A Combat Vehicle and Autom Technology					notive AH77		
COST (In Thousands)	FY1999 Actual	FY 200 Estimat	-	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH77 Advanced Automotive Technology	17830	29	782 16596	16497	16610	17280	17269	Continuing	Continuing

Mission Description and Justification: This project funds the NAC, which leverages commercial industry's large investment in automotive technology research and development and initiates shared technology programs that focus on benefiting military ground vehicle systems. The NAC, located at the Tank-Automotive and Armaments Command (TACOM), is part of the TARDEC. The NAC serves as the catalyst linking industry, academia and government agencies for the development and exchange of automotive technologies. The NAC executes collaborative research and development (R&D) contracts, cooperative agreements, and other initiatives to leverage commercial industry's investment in well-defined, high return-on-investment areas tied to key Army science and technology objectives for advanced land combat. The NAC focuses collaborative R&D contracts on key military automotive technology thrust areas to include: fuel efficiency, vehicle modernization, crew safety, maintenance, and logistics improvement and manufacturing innovation with the goal of (a) improving the performance and endurance of ground vehicle fleets, and (b) reducing ground vehicle design, manufacturing, production, and operating and support costs. Two-way industry/government technology transfer is pursued under Cooperative Research and Development Agreements (CRADAs). The NAC also leverages the Army's Dual-Use Science and Technology (DUS&T) resources. Industry joint investment under the NAC DUS&T programs exceeds \$65M. The activities of the NAC are supported by other government agencies via a linkage created under Memoranda of Agreement, and oversight is provided by a Senior Advisory Board, which includes representation from appropriate program executive offices and program managers, the User, the Army staff, the U.S. Marine Corps and OSD. These linkages permit the NAC to consolidate the collective expertise of federal government departments such as Energy, Transportation and Commerce and other DoD agencies. The NAC performs basic research in PE 0601104A, project BH73 (NAC). Major contractors include: ARCCA, Inc.; Penns Park PA; FOCUS: Hope, Detroit, MI; University of Texas, Austin, TX; Environmental Institute of Michigan, Ann Arbor, MI; Oshkosh Truck Corporation, Oshkosh, WI; Lockheed Martin Inc., Lexington, MA; Rocky Research Inc., Boulder City, NV; USCAR-PNVG/Ford, Dearborn, MI; Cummins Engine Company, Columbus, IN; ICRC Energy Inc., Oakton, VA; Radian, Inc., Alexandria, VA; Baum, Romstedt Technology Research Corp. (BRTRC Inc.), Fairfax, VA; TASC. Inc, Reading, MA; Southwest Research Institute, San Antonio, TX; Electronic Data Systems, Troy, MI; University of Wisconsin, Madison, WI; University of Iowa, Iowa City, IA; Evans and Southerland Inc., Salt Lake City, UT; AB Technologies, Alexandria, VA; Lockheed Martin Control Systems, Johnson City, N.Y; Ford Motor Company, Dearborn, MI; Continental Teves, Inc., Auburn Hills, MI; Sunline Services Group, Thousand Palms, CA; Ultramer Inc., Massillon, OH; Mobile Medical International, St. Johnsburg, VT; Oakland University, Rochester, MI, General Dynamics Land Systems (GDLS), Muskegon, MI

### **FY 1999 Accomplishments:**

- Under the Army's DUS&T, researched and investigated series and parallel hybrid electric drive, engine injection system and supercharger design improvements, improved engine configurations, and advanced lightweight materials; new simulation tools in a distributed interactive environment for real world simulation of ground vehicle operation and analysis of man-machine interface.
- 3622 Integrated key commercial automotive technologies (engine, brakes, air-conditioning, diagnostics, crash protection) into light and heavy wheeled demonstrators and engine, air-conditioning, diagnostics technologies into tracked vehicle demonstrator.

Project AH77 Pages Exhibit R-2A (PE 0602601A)

		ARMY RDT&E BUDGET ITEM JUSTIFI	CATION (R-2A Exhibit)	DATE <b>Febru</b>	ary 2000
BUDGET A  2 - App	CTIVITY  Died Res	search	PE NUMBER AND TITLE 0602601A Combat Vehicle Technology	•	PROJECT AH77
FY 1999	Accompli 420	shments: (continued)  - Integrated commercial computer aided components with  - Continued to build, test and validate redesigned 6.2 L en the High Mobility Multi-Purpose Wheeled Vehicle (HMM)  - Completed investigation of critical diesel fuel reforming chassis equipped with a hybrid electric drive system.  - Participated in Simulation Through the Life Cycle (SIM-	gine, implemented changes based on te WV). technology for use with fuel cell power s	sting results, and integrated redes	signed engine into
Total	17830				
FY 2000 I	Planned Pi	rogram:			
	12191	- Research and investigate, under the Army's DUS&T, tec Medium Tactical Vehicles (FMTV), Class 8 parallel hybric and collaborative design, development of the virtual distri- virtual proving ground, and enhancing soldier safety throu - Perform HMMWV vehicle endurance tests with reconfig- assessment and analysis.	d electric line haul truck, manufacturin buted collaborative environment and cre gh the development of the personal visu gured 6.2L engine, perform producibilit	g innovation through man-in-the eating a vehicle and heavy vehicle alization environment. y study, conduct operational & sa	-loop simulation e equipment vings (O&S) cost
•	3852	- Integrate key commercial automotive technologies (engi wheeled demonstrators and engine, air conditioning, diagn			and heavy
•	9640	<ul> <li>This congressionally directed program will research the current test truck, and conduct extended laboratory, tra</li> <li>Integrate and test optimized controls and subsystems with</li> <li>Build two additional fuel cell powered trucks for in-service</li> </ul>	ck and on-road tests. n the diesel-fueled reformer and fuel cell	l power system.	-
•	3369 730	<ul> <li>This one year congressionally directed "smart truck" prograpplicability to military wheeled vehicles.</li> <li>Complete investigation of integration plan for hardware,</li> <li>Complete definition of initial and final designs for the ele</li> <li>Complete acquisition and integration of hardware and so</li> <li>Complete performance of engineering level tests and eval</li> <li>Complete validation of vehicles to User representatives a</li> <li>Small Business Innovative Research/Small Business Tecl</li> </ul>	gram will perform market analysis of en software, informational, and human intectronic architecture and vehicle integra ftware. luations. and make recommendations based on fir	nerging vehicle electronic technologierfaces for the selected technologition.	logies for
Total	29782	Small Submess Informer Research/Small Business Tech	morogy riumorou riograms.		
Project A	H77	Da	ge 8 of 17 Pages	Exhibit R-2A (PE 0602	20044)

		ARMY RDT&E BUDGET ITEM JUS	TIFICATION (R-2A Exhibit)	Pebruary 20	00
BUDGET A <b>2 - App</b>	CTIVITY Died Res	search	PE NUMBER AND TITLE  0602601A Combat Vehicle and Au Technology		RОЈЕСТ <b>∖Н77</b>
FY 2001 F	Planned Pr				
•	12612	- Investigate and test automotive technologies under t logistics and maintenance improvement.	the DUS&T in the areas of fuel efficiency, vehicle mode	rnization, manufacturing, auto	motive
•	3984	- Integrate key commercial automotive technologies (	engine, brakes, air conditioning, diagnostics, crash prot	ection) into the light and heavy	y wheele
Total	16596	demonstrators and engine, air conditioning, diagnosi	tics technologies into the tracked vehicle demonstrator.		
Project A	H77		Page 9 of 17 Pages	xhibit R-2A (PE 0602601A)	

ARMY RDT&E BUDGET ITE	February 2000								
BUDGET ACTIVITY 2 - Applied Research	0	PE NUMBER AND TITLE 0602601A Combat Vehicle and Auton Technology						PROJECT <b>AH82</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate		FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH82 Non-Ozone Depleting Substance Technology	1304		0 0	0	0	0	0	0	1304

Mission Description and Justification: The objective of this project was to identify and evaluate non-ozone depleting fire suppression substances for application to ground combat vehicles. Due to the ozone depleting potential of Halon 1301, the Clean Air Act of 1990 and DoD Directive 6050.9 require that alternate extinguishing agents be identified to maintain crew and vehicle survivability and supportability. Environmentally and toxicologically acceptable replacements for Halon 1301 were demonstrated in engine and crew compartment fire suppression systems. Testing was performed to meet Tier 1-3 Army Surgeon General and Environmental Protection Agency requirements. Investments have been successful in selecting two agents for ground vehicle engine compartments, and retrofits are underway. Two crew compartment agents and delivery systems have also been demonstrated. This project was completed in FY99 and recommendations will be made in 1QFY00 to affected vehicle program managers for follow-on system integration. At the end of FY99, the Army invested over \$18 million in this area and succeeded in identifying acceptable fire suppressant agents for combat vehicle engine and crew compartments. This project complemented the DoD Next Generation Fire Suppression Technology Program to identify materials more suitable than currently available alternatives for mission-critical military applications. System development contractors included Santa Barbara Dual Spectrum, Goleta, CA; Primex Aerospace, Redmond, WA; Pacific Scientific, Duarte, CA; and Walter Kidde Aerospace, Wilson, NC. Alternative agents were purchased from DuPont Inc., Deepwater, NJ; Great Lakes Chemical, Lafayette, IN; and 3M, St. Paul, MN.

#### **FY 1999 Accomplishments:**

- 900 Completed performance testing of 6 selected alternative fire extinguishing systems.
- 110 Completed long-term toxicology studies initiated in previous year.
- 130 Completed system design guidelines to integrate selected agent and delivery system into affected vehicles.
- 164 Completed breakdown product studies of 8 alternative agents.

Total 1304

FY 2000 Planned Program: Project not funded in FY 2000.

**FY 2001 Planned Program:** Project not funded in FY 2001.

Project AH82 Page 10 of 17 Pages Exhibit R-2A (PE 0602601A)

ARMY RDT&E BUDGET IT	ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)									
BUDGET ACTIVITY 2 - Applied Research	0	PE NUMBER AND TITLE 0602601A Combat Vehicle and Auton Technology						PROJECT <b>AH91</b>		
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	-	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost	
AH91 Tank and Automotive Technology	8886	165	595 12865	14268	15988	18536	20857	Continuing	Continuing	

Mission Description and Justification: This project provides innovative vehicle concepts and enabling technologies for FCS. This project also researches and matures potential product improvements to fielded equipment and develop advanced systems that will enable the Army to meet its new vision. Program activities, such as conceptual designs, virtual prototyping, performance analyses and battlefield wargaming of ground vehicle systems, identify promising emerging technologies meeting approved and emerging U.S. Army Training and Doctrine Command (TRADOC) requirements. They also quantify benefits, burdens and trade-offs related to ground vehicle applications. The project includes ten areas: (1) vehicle concepts; (2) mobility; (3) integrated survivability; (4) vehicle electronics (VETRONICS) and intra-vehicle digitization; (5) advanced vehicle structures; (6) simulation/analysis; (7) military fuels and lubricants; (8) water purification technology; and (9) vehicle related countermine technology and (10) gap/obstacle crossing technology. Technologies are being pursued to address advanced mobility, survivability, advanced structures, and lethality requirements of lighter, digitized, more deployable vehicles, and less Petroleum, Oil and Lubricants (POL) logistic trail. Activities are closely coordinated through TRADOCs Mounted and Dismounted Battlespace Battle Labs; Program Executive Office for Ground Combat and Support Systems; Army Research Laboratory (ARL), and the Defense Advanced Projects Research Agency (DARPA), Tri-Service. Tank and automotive virtual prototyping provides seamless sharing of databases/engineering models, allowing more rapid and efficient integration, assessment and transfer of DoD and commercial vehicle technologies. Vehicle electronics will be based on adapting commercial electronic standards and architectures for combat vehicle battlefield unique requirements. The survivability technologies, which include non-armor approaches such as signature reduction, countermeasures, active protection, and damage reduction, complement, but do not duplicate, work performed under the armor exploratory development project (DC05) in this PE. Other government agencies include: Defense Advanced Research Projects Agency, Arlington, VA; Red River Army Depot, Texarkana, TX. Major contractors include: Cadillac Gage Textron, New Orleans LA; Soucy International, Drummondville, Quebec; Pentastar, Huntsville, AL; Michigan Technological University, Houghton, MI; United Defense Limited Partnership, San Jose, CA; University of Texas, Arlington, TX; Oakland University, Rochester Hills, MI; Gonzales Engineering, Troy, MI; Boeing Corporation, St. Louis, MO; University of Dayton Research Center, Dayton, OH; Monterey Technologies Inc., Monterey, CA; DCS Corp, Alexandria, VA.; Texas Instruments, Dallas, TX; Southwest Research Institute, San Antonio, TX; Separation Systems Inc., San Diego, CA, Scientific Systems, Boston, MA; University of California, Berkley, CA; General Dynamics Land Systems Division, Sterling Heights, MI, Chang Ind., Salt Lake City, Utah.

### FY 1999 Accomplishments:

Researched electric actuator for active suspension units; evaluated semi-active suspension potential via simulation for improved ride and platform stability with roll control in 25 ton combat vehicle class; supported future fuel efficient platforms through the development of more durable nitrile rubber track pads and light weight rubber band track.

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### DATE **ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)** February 2000 BUDGET ACTIVITY PE NUMBER AND TITLE **PROJECT** 2 - Applied Research 0602601A Combat Vehicle and Automotive **AH91 Technology** - Conducted high temperature lubricant evaluations on a multi-cylinder engine; prepared for high temperature, high nickel alloy head material and coated piston tests on high temperature capable single cylinder engine; and leveraging with international cooperative research and development funds, conducted high power density test on a technology screening engine (Army part of US-Japan cooperative research agreement) all designed to accomplish low heat rejection, high fuel economy engines for future fuel efficient army platforms. FY 1999 Accomplishments: (continued) - Completed evaluation of fuels, lubricants, and additives for improvement in fuel economy, vehicle signature and component life requirements. Participated with DOE on fuel impacts on advanced engine system emissions. Evaluated use of biodegradable grease and hydraulic fluids, and evaluated environmentally acceptable solvent to supplement products under current Army purchase description. 3302 - Proved the feasibility of retrofittable wide-angle optical viewing system design which can incorporate laser-limiting materials. New contract released for fabrication of advanced vision device for unity vision. - Developed family of new, hybrid structures concepts and candidate integrated signature-ballistic armor system for light and medium weight future vehicle systems with detectability reductions; established baseline vehicle concepts, defense zones, and design criteria for each zone. - Determined constraints, performance requirements, and analyzed unique active protection hemispherical and kinetic energy countermeasures for universal threat application. - Evaluated concept alternatives for voice recognition, 3D audio, and indirect vision driving; selected approach, and conducted detailed designs for future integration into mobile reduced crew testbed. - Conducted technology assessments in support of the Army Science Board. Conducted Army laboratory capability assessments, drafted contract solicitation and sponsored industry day in support of the joint DARPA/Army FCS program. Total 8886 FY 2000 Planned Program: 3938 - Research innovative vehicle concepts, engineering analysis, operational effectiveness evaluations and a virtual environment in support of the development of a lightweight, strategically deployable, agile, survivable and tactically mobile force for the Army. Directly supports the development of requirements and technology for the joint Army/DARPA FCS program. -Investigate advanced concepts from technology spin-offs from FSCS and FCS demonstrating the performance and cost implications of potential modifications to the Abrams Tank, Bradley Fighting Vehicle M113 family of vehicles, Crusader and Medium Brigade Vehicles. - Evaluate commercial and military technologies and systems to determine capabilities and deficiencies. Determine capability requirements for military tactical vehicles to support the future combat force. Provide technologists vehicle level and system guidance. Research and investigate concept level virtual prototypes of future heavy tactical vehicle configurations that will improve mobility, transportability, supportability, and survivability. - Complete investigation of immersive visualization environments by networking with the user to show the technology application for concept tradeoff analysis. Determine the best use for the technology developed in the vehicle system development process. Exhibit R-2A (PE 0602601A) Project AH91 Page 12 of 17 Pages

	ARMY RDT&E BUDGET ITEM JUSTIFIC	CATION (R-2A Exhibit)	DATE <b>Febr</b>	uary 2000
BUDGET ACTIVITY  2 - Applied Re	esearch	PE NUMBER AND TITLE  0602601A Combat Vehicle and I  Technology	Automotive	PROJECT <b>AH91</b>
• 5036	<ul> <li>Conduct field testing of the Electromechanical Suspension cross country conditions including steering and braking at h country operations.</li> </ul>			
		In and fabricate advanced componentry for dentry wheeled vehicle active suspension.  It; screen and test fuel additives. Select product cement materials; conduct engine emissions test ations with candidate energy enhancement may vehicles. Investigate potential of available and aintenance.  Investigate potential of available and aintenance.  Investigate potential of available and aintenance.  In the triangle of a control of a contr	s to conduct multi-cylin sting on candidate energy terials. It emerging technologies and on prototype comportant term vehicle system to bed. It is corporate laser-limiting chand complete the deture vehicle programs; of achments and integrate aults to Future Scout and coffic emphasis on Kinetical define architecture for the conductive of the conductive	der engine gy enhancement s for POL and site bridging as. Evaluate materials. monstration and define alternative candidate zone I Cavalry System ic Energy rod or integration into
Project AH91	VIC simulations.	13 of 17 Pages	Exhibit R-2A (PE 060	02601A)

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)  DATE February 200							
BUDGET ACTIVITY  2 - Applied Research			PE NUMBER AND TITLE 0602601A Combat Vehicle and Auto Technology	PROJECT AH91			
• Total	112 16595	<ul> <li>Evaluate preliminary concept designs for FCS</li> <li>Identify areas of necessary additional technical investmen address the deficiencies.</li> <li>Perform detailed technology assessments and subsystem in</li> <li>Small Business Innovative Research/Small Business Tech</li> </ul>	ntegration studies for the FCS alternatives such as As				
FY 2001 P	Planned Pi	rogram:					
•	4662 4500	- Perform effectiveness, performance, cost and tradeoff anal agile, survivable and tactically mobile force for the Army.  - Complete investigation of advanced vehicle concepts valid as potential modifications to the Abrams Tank and Bradley.  - Supports the Army's vision of a medium brigade by devel-Conduct trade-off studies and supporting performance and.  - Complete research showing the utility of the collaboration the technology to actual vehicle system issues. Demonstrate technology during the trade-off analysis process to reduce the technology to the vehicle system development process.  - Complete electromechanical active suspension algorithms.	Directly supports the development of requirements are lating the performance and cost implications of robot. Family of Vehicles and Medium Brigade Vehicles. oping concept level virtual prototypes of future medius supportability analysis of heavy tactical vehicle concept tools using a series of experiments and pilot project the integration of stakeholder feedback to enhance the risk in the vehicle development process. Continue refinement on the HMMWV research test vehicle and	and technology for FCS. ic vehicles in multiple roles, as well im tactical vehicle configurations. epts. ts to verify the approach by applying the use of immersive visualization to refine the application of			
		active suspension application for hyper-mobility in combat - Continue developmental testing of the demonstrator engine engine for high power density, low heat rejection and fuel engine for high power density, low heat rejection and fuel engine the logistic tail of the force by continuing engine-tenhance lubricants products to operate successfully with endynamometer tests to address other engine types; investigation investigation; - Investigate and test an oil condition monitor and/or POL of software. Conduct bench-level testing of breadboard prototonates are comparison studies of composites vs. In Prototyping simulations and studies of new and unique bride - Investigate, test and characterize obstacle-marking system system deployability and cost to prepare for FY2002 test be	ne. Continue high temperature performance and dur- economy (Cooperative Research Program with Japan) fuel-lubricant compatibility evaluations with candidatergy enhancement material, initiate field testing of en- e onboard vehicle coalescer/filter to work with +100 quality sensor suite for possible in-line/onboard appli- types and controlled field experimentation. netallics and their applicability towards military bridges lage launching techniques which are applicable to FCS as based on FY2000 analysis. Perform detailed assess	te energy enhancement materials, hergy enhanced materials; expand additive complete particle size cations. Validate interfacing ging technologies and begin Virtual S.			
Project Al	H91	Page	e 14 of 17 Pages Exhi	bit R-2A (PE 0602601A)			

	February 2000			
BUDGET ACTIVITY  2 - Applied Research			PE NUMBER AND TITLE 0602601A Combat Vehicle and Aut Technology	omotive PROJECT AH91
•	1881	<ul> <li>Integrate and evaluate NRDEC laser protection materials materials.</li> <li>Analyze structural implications of active protection system of crew and sensitive components from shock damage.</li> <li>Evaluate/validate performance levels via component struc "hybrid" vehicle designs; develop preliminary structural an - Conduct simulations to determine viable system concept devaluations.</li> </ul>	ns, including effects of the impact of residual penetr tural and ballistic tests; perform preliminary structu d ballistic performance with small element tests.	rators and measures for the protection
FY 2001 I	Planned I	Program: (continued)  - Identify detection and hit avoidance technologies compati  - Assess armor/structure concepts developed under project I development program to be continued in future years for gr	DC05 for future growth potential and flexibility to	
•	1822		GUI) for semi-autonomous driving for future integra are Army; conduct developmental testing of prototype	
Total	12865			
Project AH	<b>I</b> 91	Page	e 15 of 17 Pages Ex	nibit R-2A (PE 0602601A)

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)							February 2000			
BUDGET ACTIVITY  2 - Applied Research		PE NUMBER AND TITLE  0602601A Combat Vehicle and Automotive Technology						PROJECT <b>AHH7</b>		
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	-	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost	
AHH7 Future Combat Systems (FCS)	0		0 7752	19564	0	0	0	27500	27316	

Mission Description and Justification: FCS, the Army's top priority Science & Technology program, is the focus of this project. The FCS will transform the Army to a more strategically deployable, agile and survivable force. The success of FCS is critical to the transformation of the Army to meet its new vision. Concept exploration and trade studies leading to FCS demonstrations will be performed in this project. This project provides the enabling mechanism for the Army, working with DARPA and industry partners, to research and provide alternative, innovative conceptual designs, virtual prototypes, modeling, simulation, wargaming, performance analysis and evaluation of emerging technologies when packaged in a ground combat system in response to the draft Mission Need Statement (MNS). The intent of that MNS is to develop a force structure around a system of systems capable of addressing a spectrum of threats from non-lethal to full combat, while sustaining itself for an extended period. Industry partners will deliver virtual designs during phase I of the contract that will be evaluated for battlefield utility, supportability, deployability and life cycle costs. A thorough evaluation of the benefits and burdens of competing emerging technologies by functional operational capability area will be completed. This project will provide an extensive evaluation of competing lethality technologies, including electromagnetic guns, missiles, electro-thermal cannon, directed energy weapons and hybrid combinations of these technologies. Advanced target acquisition and engagement sensors, and digitized electronic suites also will be researched. Emerging survivability technologies including active protection and signature management, advanced armors and lightweight structures will also be evaluated. Hypermobility technologies including, electric drive, high-density low burden diesel, turbine and advanced fuel cell engines and alternative prime power sources will be investigated. Advanced active, and semiactive suspension technologies will be researched. Command, Control and situational awareness alternative vehicle electronic architectures will be considered and investigated. These include voice and non-voice digital communications suites, anti-fratracide devices, embedded navigation, prognostics, diagnostics, sensors, embedded learning and crew aids. At the vehicle level, competing designs will be evaluated for their ability to perform combat missions across the full spectrum of operations. These include strategic transportability, peacekeeping operations, urban warfare, countermobility, amphibious operations, offensive and defensive tactical operations. Innovative solutions may include manned and unmanned special mission modules and multiple component designs. Additionally, the project is supported and sponsored by Headquarters, Training and Doctrine Command, and by its various Battle Labs. In FY03, this program transitions to PE 0603005A, project D440.

**FY 1999** Accomplishments: Project not funded in FY 1999.

**FY 2000 Planned Program:** Project not funded in FY 2000.

#### **FY 2001 Planned Program:**

- 2981 Research and define initial force concepts as a result of tradeoff assessment process.
- 2783 Investigate and test innovative system concepts that reflect the force concept in a system of systems structure.
- 1988 Perform effectiveness, performance and cost analysis on system concepts to quantify the force and system performance and payoffs.

Total 7752

Project AHH7 Page 16 of 17 Pages Exhibit R-2A (PE 0602601A)

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)									DATE <b>Fe</b>	DATE February 2000		
BUDGET ACTIVITY  2 - Applied Research					060	UMBER AND D2601A ( Chnology	Combat \	PROJECT				
		COST (In Thousands)	FY 1999 Actual	FY 2 Estin		FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AT21 21st Century Truck (T21)					0	12920	0	0	0	0	0	12920
nation. The vehicle interior industry, of FY 1999	he NAC is telligence a other gover Accompli Planned I	the lead for this initiative. The 21 <sup>st</sup> Centural and safety. The NAC will establish joint terment agencies and academia.  Shments: Project not funded in FY 1999.  Program: Project not funded in FY 2000.  Program:  - Complete research and investigation of coatings, coolants and cooling systems of motor controllers, integrated gate bipola.  - Complete investigation and test intellige efficiency, safety and quality of driving the complete investigation and testing of a and that will facilitate the use of Solid Complete improvement and increase the corrosion resistance, vehicle life cycle, decomplete research showing improvement density, weight and cube of present general control of the complete research showing improvement general cube of present general corrosion resistance, weight and cube of present general cu	ry Initiative vechnology defects of high power omputer content of transistors, gence technological fucks. Alternative fuel Cene application durability and ents in fuel ce	densit rolled and ad ogies t els to n ll prop of cur mobili ell tech	ey engi energ lvance that in meet m vulsion rrent a ity.	ines, lightwey management energy stovolve both in initiary requires systems.	els, advance is five principal eight engine/ ent systems, orage systems irements for irements for	d propulsion al focus are components electric traces. and control the fuels with herials technology.	s, high temption motors, technology to igh stored e ologies that	materials, recost-shared perature engirelectric generation of improve further the same and the s	duced parass partnerships ne materials, erators, high el efficiency y, reduced en rease payload	engine a power y, driving missions d,
Project A	Г21			Page	17 of	17 Pages			Exhib	it R-2A (PE	0602601A	)